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AUTHOR Attashani, Abdulrazik; Pesenti, Roberto A.
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ABSTRACT

Reported is a study related to a Project on an Information Memory Model in which the performance of children living in two different cultures (Libyan and American) was compared on two problem solving tasks to investigate cultural differences in memory information processing. One task was the chemical bodies experiment studied by Piaget and Inhelder and the other was a figural sorting task. The population in the study consisted of tenth-grade students (N=54/country). The Libyan sample consisted of 22 boys and 32 girls; the American, 27 boys and 27 girls. A total of 40 variables was studied. Data were analyzed using two-way analysis of variance and correlational procedures. When data were analyzed, the major conclusion appeared to be that the information memory flow of the students had attributable cultural differences when compared to Piagetian task performance and memory cognitions. (Author/PEB)

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INFORMATION MEMORY PROCESSING AND RETRIEVAL:
CULTURAL DIFFERENCES OF LIBYAN AND AMERICAN
CHILDREN IN A SORTING AND PIAGETIAN TASK

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ABDULRAZIK ATTASHANI AND ROBERTO A. PESENTI
UNIVERSITY OF PITTSBURGH

(PROJECT ON AN INFORMATION MEMORY MODEL)
ADDRESS: P111M, 2610 G.L., SCHOOL OF EDUCATION
UNIVERSITY OF PITTSBURGH
PITTSBURGH, PA. 15260

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Introduction

Do humans living in different culture environments differ in the memory functions of doing problem solving tasks? This is a challenging question, because if true, the way in which the environment effects the human, over a number of years, may alter the end products of cognitive activities.

There is some evidence that human behavior differs for cultures. Weir (1) and Kelley (2), tests of verbal, logical, and empirical forms, independently reported that eleven to sixteen year old subjects in New Guinea did not have any "trace of formal operational thoughts." Vernon (3) studied performance of concept tasks by Eskimoes and Canadian Indians. They had deficiencies in the conservation of quantity, liquid, and area when compared to English norms. The same relationship was found to the concept of time. However, Eskimoes were similar to Caucasians regarding performance on tasks involving spatial concepts, whereas Canadian Indians were better regarding mental imagery. Vernon (4) also compared task performances of West Indian and English subjects. The former subjects scored less on the conservation of quantity, liquid, and area, but did not differ from English subjects in the conservation of substance, logical inclusions, and time and horizontality concepts. ZaRour (5) did a comparison study of one done for American subjects in the conservation of number and liquid. His subjects were Beirut, Lebanon children aged five to nine years. He found the Lebanese subjects lagged behind American subjects for age levels of performance of conservation tasks. Furthermore, he found Lebanese males surpassed females in performance of the tasks.

These studies are of research value for understanding culture behavior differences, but do not reveal the memory processing factors for the differences. This kind of research inquiry is possibly hindered by the nature of the test materials used by subjects of different cultures. Furthermore, culture-embedded overt behaviors may not be comparably observed for interpretations of differences between performances of subjects of different cultures.

There have been recent developments of the use of an information theoretic memory model to describe human behavior. These researchers at the University of Pittsburgh (6,7,8) have quantified the quality of verbal and nonverbal behaviors. The memory model (9) they used has been found to quantitatively define the information flow of learning tasks of humans and have discovered that flow is related to levels of subsequent cognitions.

As members of the Project on the Information Memory Model (PIMM) we decided to determine the nature and levels of information processed by American and Libyan subjects in the performance of tasks. Furthermore, we developed a research design for

comparing performances in a Piagetian task and in one done in other studies of American subjects (8,9). This enabled us to pose the research question of whether or not subjects of different cultures process memory information differently in learning and cognition tasks.

Purpose of the Study

The aforementioned research of cultural differences in behavior lacked certain considerations of research procedure. The behaviors of task should be observed for the individual actions and the sequence of the actions. Herein is probably a standard for the comparison of behavioral differences. This concept was heeded by selecting two tasks for experiments with Libyan and American subjects.

The first task was the chemical bodies experiment studied by Piaget (15) & Inhelder (10). This task involves a selection of groups of chemical bodies for obtaining a desired state of affairs. It was originally used to examine the relationships between combinational and propositional operations (15). However, Piaget and Inhelder obtained research data by observing verbal behavior. Such a replication by us would have introduced a problem of semantic structure differences of subjects of the two cultures. We decided to use an operations research approach to avoid this problem of interpreting behavior observations. Consequently, we devised a set of probability interpretations of the quality of behaviors and behavior responses to instances.

The second task of the study was selected for three reasons. The figural sorting task used in the study was one done by over one thousand American subjects of different ages (6,9). It therefore provided data for comparison of significances of different ages of subjects. The second reason was the task involved a recall performance which could be used to study differences in cognition. The third, and more important reason, was the nature of the elements of the task. The sorting task involved attributes familiar to subjects of both the Libyan and American cultures. They both were known to have experience with geometric shapes, colors and Arabic numbers.

These criteria for a research study were essential for standardizing policy as we were to try to determine differences of culture behaviors. This policy was accentuated as our objective was to use a memory model for defining information flow in cognitively performing the two tasks. By such a normalizing design of the experiment our findings of information processing would be given greater validity. In this way, by building on established information theoretic memory processing concepts (6,7,8,9), we could do a unique study of how Libyan and American subjects of the same school grade level differed in the same cognitive tasks.

Procedure

The population in this study was tenth-grade students in the Libyan and American cultures. Each sample consisted of 54 students. The Libyan sample contained 22 boys and 32 girls randomly drawn from the city of DERNA on the Mediterranean Coast in the East of the Country. The American sample contained 27 boys and 27 girls randomly drawn from a high school at the City of Ambridge, Pennsylvania.

Two tasks were given to the subjects. These were:

a) Classification and sorting of geometrical figures designed by Dr. Gene Moser at the University of Pittsburgh. This task consists of 14 geometrical figures (circles, squares, triangles) with different colors (blue, green, red, and black). These figures were drawn on an 11.0" x 8.5" transparency for overhead projection. The location of each figure on the transparency, as well as the identity number assigned to it, was random.

In the first part of this task, subjects were asked to form as many groups of these figures as they can, giving reasons for each of their group formations.

In the second part of the task, subjects were asked to recall the figures by their location and number. They were also asked to write the color of each figure recalled and to indicate the order of those figures when they were recalled.

Data collected from this task was used to study four categories of behavior:

- 1) reasons for set formation and the number of attributes the subject was able to use when he or she grouped figures to form a set.
- 2) subject's behavior was coded into a 14 x 14 matrix to calculate information theoretic values. Only eight of the 36 values originally obtainable from the matrix were used for the purpose of this study.
- 3) subject's recall was analyzed as to the attributes of shape, color and identification numbers of elements recalled, the order of elements by which the subject recalled the figures, and
- 4) subject's recall and his information processing efficiency were used to calculate the amount of useful information measures the subject was able to utilize in his processing of the task.

b) The second test was the famous Piagetian Combination of Colorless Chemical Bodies Task (15). This test was administered on an individual basis. Each subject was presented with five identical flasks containing colorless, odorless liquids as follows:

X: diluted sulfuric acid

P: oxygenated water

Z: sodium thio sulfate

L and W: water

G: potassium iodide

(constant in each combination) (from the fact that oxygenated water oxidizes potassium iodide in an acid medium; $X + P + G$ yields a yellow color, if Z is used no color will be observed)

The subject was presented with two beakers, one containing a mixture of sulfuric acid and oxygenated water and the other water. The experimenter poured some drops of potassium iodide into each of the two beakers and the subject was asked to note the different reactions.

Using the five solutions, the subject was asked to combine three of them with potassium iodide in each trial in order to produce the yellow color. After the subject obtained the color he was asked to reproduce it again, to observe whether he or she could recall the right combination. The subject's behavior was coded into a 5 x 5 matrix for obtaining information theoretic measures.

The data collected from this task was used to study three categories of behavior:

- 1) the sequence of solution combinations was analyzed to determine the average quality and the set redundancy of each subject's combinations.^a
- 2) The number of trials it takes the subject to perform before he or she discovered the negative effect of sodium thiosulfate, and the probability that the subject avoided this negative effect was calculated.^b
- 3) Coded behaviors were analyzed and ten information theoretic measures were studied for the purpose of this paper.

A total of forty variables were studied in this project. Two-way analysis of variance was used to determine the significance of the effect of each of these variables, by culture and sex. Analysis of variance was also used to compare behaviors of both tasks. Coefficients of correlation were used to study the relationships among these variables for male and female characteristics in each of the two cultures.

^a Hereafter referred to as the K factor

^b hereafter referred to as the S factor

Results

The performance of American and Libyan tenth grade subjects in the chemical bodies task and figure sorting task is shown in Table 1 and Table 3. The results of the analysis of variance for significant differences between the two groups are listed in the Appendix. A diagrammatic display of these differences is found in Figure 1.

The American subjects had higher redundancy scores in the chemical bodies task but the Libyan subjects processed a greater amount and rate of chunk related to useful information in the short term memory (LTM, %LTM). The American subjects also processed significantly more elements of sets (hereafter called messages) in doing the figure sorting task. The differences in set formation were due to their recording more shape and color sets than were done by the Libyan subjects. The Libyan subjects constructed set formations for "other" reasons, or as reasons not categorized as listed on Table 1. The Libyan subjects also practiced more sets with reasons of two or more attributes than done by American subjects. The two or more attributes category was noted where a subject formed a set for color and shape or shape and identity number, etc. reasons (Table 1).

The levels of input spuriousness (NOISE:X) indicated that American subjects tended to regard the task as one of a problem solving (high input spuriousness) whereas the Libyan subjects considered it as much lower level problem solving (Table 3).

The Libyan subjects provided a greater amount on encoding (CODE, % CODE) and original matrix useful information (REAL M¹, % REAL M¹) than the American group. On the other hand, the American subjects had significantly greater amounts of LTM:M¹ and % LTM:M¹ information per sorting message than was processed by the group of Libyan subjects.

The useful information processed by Libyan subjects was found to have been done to a greater extent in a steady state condition. They had significantly larger amounts of useful information (REAL:SS, % REAL:SS) of this kind than was processed per message by American subjects (Table 3).

The sex characteristics of the two cultures were studied for significant differences by analysis of variances. The task characteristics are listed in Tables 2 and 4 and analysis of results are found in the Appendices. Figure 1 lists the range of differences for the cultural sex groups.

The major differences of performance in doing the chemical bodies task were in the chemical body combinations and in the probability of arriving at a correct solution (S) of the task. Females in both cultures processed a greater number of flask elements than males. Libyan males had higher combinations than American males. Females in the two cultures had the same probability of arriving at the correct solution to the chemistry problem. However, American males obtained the correct solution with a higher probability than Libyan males (Table 2).

The sex characteristic groups of children showed significant performance differences in doing the sorting task. Unlike the performance in the chemical bodies task, the American males had the greatest average number of set formations for color reasons while the Libyan females had the lowest number of color sets. The opposite trend existed for the use of two-or-more attribute reasons for set formations. Libyan males were the highest and American males were the lowest in the four groups for the number of "other" reasons (Table 2).

FIGURE 1

Ranges of Levels for Characteristics of the Chemical Bodies and Sorting Task

Task Characteristics	Sex						Culture		Sex & Culture Interaction
	American		Libyan		American	Libyan			
	Male	Female	Male	Female					
A. Chemical Bodies Task:									
Messages	L ^a								
Set Redundancy (K)								H ^c	H
1/K									
Selection Probability (S)									
1/S									
B. Figure Sorting Task:									
Messages									
Practice Sets									
Practice Shape									
Practice Color									
Practice Other									
Practice Attributes									I ^d
Recall Total									
Recall Shape									
Recall Color									
Recall Number									
Information Measures									
A. Chemical Bodies Task:									
LTM:M ¹									
%LTM:M ¹									
H (Y) SS									

TABLE 1

Characteristics of the Chemical Bodies and Figures Sorting Tasks
Done by Libyan and American Tenth Grade Children

Task Characteristics	American		Libyan	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.
A. Chemical Bodies Task:				
Messages	15.50	7.6152	18.6481	10.3289
Set Redundancy (K)	.656	.4286	.4838	.5726
1/K	2.9104	3.3193	5.9994	10.4057
Solution Probability (S)	.4226	.1161	.4053	.0969
1/S	2.5530	.7610	2.6107	.6206
B. Figures Sorting Task:				
Messages	55.3889	26.7838	36.00	18.2189
Practice Sets	13.4259	7.9232	10.7407	6.3489
Practice Shape	5.1667	8.0064	1.9259	1.7467
Practice Color	3.3704	1.4704	2.4184	3.1045
Practice Number	3.2776	2.8044	2.7778	4.8161
Practice Pattern	.3704	1.1541	.1481	.4517
Practice Other	.2407	0.7252	1.3704	3.2055
Practice Attributes	1.0556	1.8675	2.3704	2.4052
Recall Total	12.0926	6.4066	11.5370	6.1605
Recall Shape	7.4815	3.3066	6.3704	5.3387
Recall Color	2.4074	2.0606	3.1667	4.5131
Recall Number	2.2037	2.4906	3.8519	4.6719

TABLE 2

Characteristics of the Chemical Bodies and Figure Sorting Tasks, by Culture and Sex

Task Characteristics	American			Libyan		
	Male	Female		Male	Female	
	$\bar{X}$	$\bar{X}$	S.D.	$\bar{X}$	$\bar{X}$	S.D.
A. Chemical Bodies Task:						
Messages	13.78	17.22	7.12	17.00	19.78	6.46
Set Redundancy (K)	.76	.57	.48	.40	.56	.30
1/K	3.02	2.80	4.04	4.24	7.21	3.32
Selection Probability (S)	.45	.40	.11	.39	.42	.10
1/S	2.38	2.73	.59	2.76	2.51	.74
B. Figure Sorting Task:						
Messages	53.07	57.70	21.36	40.09	33.19	19.48
Practice Sets	12.81	14.04	5.12	11.00	10.56	5.97
Practice Shape	4.44	5.89	3.41	2.59	1.47	1.94
Practice Color	3.81	2.93	1.66	2.77	1.72	4.28
Practice Number	3.37	3.19	3.22	1.86	3.41	2.32
Practice Pattern	0.41	0.33	1.12	0.14	0.16	0.47
Practice Other	0.11	0.37	0.32	2.18	0.81	4.29
Practice Attributes	0.78	1.33	1.85	1.45	3.00	1.84
Recall Total	11.04	13.15	6.48	10.14	12.50	4.02
Recall Shape	6.96	3.00	3.73	5.18	7.18	2.61
Recall Color	1.96	2.85	1.89	2.31	3.75	2.29
Recall Number	2.11	2.29	2.44	2.64	4.69	2.65

Information Processed for the Chemical Bodies and
Figure Sorting Tasks by Cultural Groups

TABLE 3

Libyan		American	
$\bar{X}$	S.D.	$\bar{X}$	S.D.
Information Measures			
A. Chemical Bodies Task:			
CODE	1.5551	1.4286	1.5551
%CODE	52.25	18.40	52.25
REAL:M ₁	1.2255	.3824	1.2255
%REAL:M ₁	0.3871	.1770	0.3871
LTM:M ₁	0.0704	.0488	0.0704
%LTM:M ₁	0.0681	0.0633	0.0681
NOISE:X:M ₁	0.4456	0.1771	0.4456
REAL:SS	0.1403	0.1073	0.1403
%REAL:SS	0.0327	0.0270	0.0327
B. Figure Sorting Task:			
CODE	2.2178	0.4295	2.2178
%CODE	59.55	11.49	59.55
REAL:M ₁	2.3065	0.3971	2.3065
%REAL:M ₁	0.4502	0.1840	0.4502
LTM:M ₁	0.0886	0.0714	0.0886
%LTM:M ₁	0.0437	0.0412	0.0437
NOISE:X	0.3805	0.1050	0.3805
REAL:SS	0.1439	0.1572	0.1439
%REAL:SS	0.0206	0.0269	0.0206
M-Unit	0.1712	0.0949	0.1712
M	0.0168	0.0955	0.0168
M-Useful	1.4363	7.3128	1.4363
Libyan			
CODE	2.1629	0.4842	2.1629
%CODE	71.8300	13.1300	71.8300
REAL:M ₁	2.6684	0.4586	2.6684
%REAL:M ₁	0.5899	0.1641	0.5899
LTM:M ₁	0.0602	0.0615	0.0602
%LTM:M ₁	0.0259	0.0277	0.0259
NOISE:X	0.2650	0.1261	0.2650
REAL:SS	0.2054	0.1421	0.2054
%REAL:SS	0.0285	0.0199	0.0285
M-Unit	0.2015	0.1113	0.2015
M	0.0527	0.1189	0.0527
M-Useful	4.2081	9.0561	4.2081

A different pattern was found for the recall phase of the sorting task. Females in the two cultures obtained higher scores for shape, color and total recall scores. American females recalled more shape items than Libyan females, but Libyan females recalled more color and number items than American females. Libyan males had the lowest score in shape recall while American males obtained the lowest scores in both color and number recall.

An analysis of information processed in the two tasks showed a pattern quite unlike that found for the two culture groups. There were no significant differences found due to the sex characteristic in the information flow for processing the figure sorting task. However, the previously mentioned sex groups of American males and Libyan females exhibited two significant information level extremes in the processing of the chemical bodies task. It was found that Libyan females processed the greatest amounts of $LTM:M^1$, $\% LTM:M^1$ and $H(Y)$ SS information, whereas the lowest amounts were processed by the group of American males (Table 4).

The groups of sex characteristic subjects differed in the levels of useful information needed per sorting task cognitions in the dimension algorithm. As shown in Figure I, the differences were due to variances of the males and females of the Libyan group of subjects. The larger amount of useful information (M unit, M , M useful X in Figure I) were for the female Libyan subjects. Analysis of variance for the comparison of the effect of both tasks in the two cultures is shown in the Appendices. As the two tasks were different in their desired state of affairs, so are the responses of American and Libyan subjects.

The amount of encoding of information ($CODE$, $\% CODE$) and amount of original matrix useful information ($REAL$, $\% REAL$) were all higher in the figure sorting task than in the chemical bodies task, with American subjects processing more in the chemical bodies task and Libyans processing more in the figure sorting task (Tables 3, 5).

The amount of input spuriousness ($NOISE:X$) was found to be greater in the chemical bodies task than the figure sorting task. Subjects in the two cultures did not significantly differ in the chemical bodies input spuriousness, but Libyan subjects processed the figure sorting task with less amount of spuriousness than American subjects (Tables 3, 4).

The figure sorting task showed a greater amount of differentiation between the two cultures than the chemical bodies task, those differences regarding the behavior in the two tasks was greater in Libyans than in American subjects.

The two tasks had the same amount and rate of chunking in the short term memory ($LTM:M^1$, $\% LTM:M^1$). However, Americans obtained higher chunking in the figure sorting task, while Libyans obtained higher amounts in the chemical bodies task. The difference between the two tasks was greater in Libyan than American subjects (Tables 3, 4 and Figure I). In both tasks Libyan subjects processed larger amounts of information in the steady state ($REAL:SS$, $\% REAL:SS$) than American subjects.

The following presentation of findings has been abbreviated so the reader may gain an overview of the numerous tables listing linear regression analyses between task behaviors and information measures for quantitatively describing the structural quality of the learning task behaviors. Coefficients of correlation are listed in Tables 5 through 20 and illustrated cross tasks in Figures II, III. We shall start by treating the total population ($n=108$) as one group, for a better

FIGURE 2

Significant Coefficients of Correlation Between Information Measures
of the Chemical Bodies Task, by Culture and Sex

CODE	%CODE	REAL:M ¹	%REAL:M ¹	LTM:M ¹	%LTM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS	H(Y)SS
CODE	J	J	J	*J	*J	*J	B	B	
%CODE		J	J	*J	*J	*J	AB	B	
REAL:M ¹			J	*B	*J	*J	B	B	
%REAL:M ¹				*C*D	*J	*J	D	B	
LTM:M ¹					J	CDB	*D	*D	
%LTM:M ¹						CAB	*D	*D	
NOISE:X:M ¹							*A*B	*A*B	
REAL:SS								J	CDB
%REAL:SS									CDB
H(Y)SS									

- J - all four groups of subjects
 A - American male subjects
 B - American female subjects
 C - Libyan male subjects
 D - Libyan female subjects
 * - indicates negative coefficient of correlation

FIGURE 3

Significant Coefficient of Correlation Between Information Measures
of the Figure Sorting Task, by Culture and Sex

CODE	%CODE	REAL:M ¹	%REAL:M ¹	LTM:M ¹	%LTM:M ¹	%LTM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS
%CODE	J	J	J	*J	*J	*J	*J	A*B	*B
REAL:M ¹	J	J	J	*J	*J	*J	*J	*B	*B
%REAL:M ¹				*D*B	*D*A*B	*J	*J	*B	*B
LTM:M ¹				*J				DE	DB
%LTM:M ¹					J			D	D
NOISE:X:M ¹								B	B
REAL:SS									CDB
%REAL:SS									

J - all four groups of subjects

A - American male subjects

B - American female subjects

C - Libyan male subjects

D - Libyan female subjects

* - indicates negative coefficient of correlation

TABLE 4

Information Processed for the Chemical Bodies and Figure Sorting Tasks, by Culture and Sex

Information Measure	American				Ll'yan			
	Male		Female		Male		Female	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
A. Chemical Bodies Task:								
CODE	1.2097	.3938	1.1004	.4109	1.0899	.3384	1.0723	.3922
%CODE	55.06	17.70	49.44	18.99	48.77	15.12	48.40	17.44
REAL:M ¹	1.2691	.3831	1.1818	.3839	1.1755	.3155	1.1748	.3714
%REAL:M ¹	41.81	17.03	35.60	18.13	35.94	13.08	34.99	20.60
LTM:M ¹	.0594	.0360	.0814	.0575	.0855	.0553	.1040	.0618
%LTM:M ¹	4.96	3.61	8.66	7.84	8.86	6.34	10.15	7.60
NOISE:X:M ¹	.4224	.1729	.4687	.1814	.4738	.1388	.4638	.1652
REAL:SS	.1397	.1017	.1409	.1146	.1167	.0961	.1674	.1227
%REAL:SS	3.29	2.59	3.25	2.85	2.57	2.30	3.82	3.05
H (Y) SS	2.3443	.1068	2.3807	.0648	2.3504	.1152	2.4299	.2700
B. Figure Sorting Task:								
CODE	2.2693	.4124	2.1663	.4476	2.4637	.4481	2.7155	.4879
%CODE	61.04	10.97	58.07	12.01	67.42	12.37	74.86	13.27
REAL:M ¹	2.3644	.3805	2.2486	.4120	2.5148	.4159	2.7739	.4621
%REAL:M ¹	46.61	11.31	43.43	11.78	53.36	14.41	62.87	16.79
LTM:M ¹	.0950	.0825	.0823	.0593	.0601	.0606	.0603	.0632
%LTM:M ¹	4.55	3.94	4.19	4.40	2.88	3.07	2.39	2.58
NOISE:X:M ¹	.3641	.1107	.3970	.1101	.3092	.1165	.2347	.1252
REAL:SS	.1545	.1250	.1333	.1859	.2389	.1718	.1823	.1168
%REAL:SS	2.14	1.78	1.98	3.41	3.92	2.35	2.55	1.66
M-Unit	.0135	.1095	.0202	.0811	.0076	.0690	.0837	.1369
M	1.273	8.349	1.610	6.265	.5861	5.342	6.698	10.26
M Useful	.1669	.1084	.1755	.0810	.1622	.0688	.2285	.1270

TABLE 5

Significant Coefficients of Correlation for Sorting and Chemical Bodies Characteristics, Libyan Males*

Task Characteristics	Set		Solution		S. Messages	R. Total	R. Shape	R. Color	R. Number
	C. Messages	Redundancy (K)	1/K	Prob. (S)					
A. Chemical Bodies Task:									
C. Messages									
Set Redundancy (K)	-.63		.70	-.56	.52		.40		
1/K		-.74		.43	-.45				
Solution Prob. (S)	-.56	-.74	-.40		.41				
1/S	.52		.41	-.95	-.95				
B. Figure Sorting Task:									
S. Messages	-.44	.49	-.44	.36		.44	.51	.64	
R. Total						.44			
R. Shape									
R. Color									
R. Number									
M Unit	-.36			-.40	.41		.56		.47
M	-.36			-.40	.41		.56		.47
M Useful	-.36			-.40	.41		.56		.47

*Significant at .1 level.

understanding of relationships among variables in this study (keeping sex, culture constant).

Set redundancy (K) of the chemical bodies task was found to be positively correlated to the solution probability (S) of the same task. On the other hand, while S is related only to information processing behavior in the same task, K correlates with the processing behavior of both tasks. Set redundancy correlates negatively with sets grouped according to "color" reasons. While K could be used to predict set formation, $1/K$ (the inverse of set redundancy) was found to correlate positively with the recall of figure characteristics according to "shape", "color" and "number" reasons.

As far as forecastability in the recall of figure characteristics, by reasons given for set formations is concerned, it was found that groupings of sets for "number" reasons and according to two or more "attributes" were the best predictors (among grouping practices) of recall (both correlate positively with recall shape, color, number).

Behavioral information processing values of the two tasks could be used to predict set formation and figure recall in the geometrical figure task as well as solution probability and set redundancy of the chemical bodies task. In the figure sorting task; short term chunking, chunking efficiency of input spuriousness correlated positively with set formation. On the other hand, recall of figures could be predicted (as expected, since it is a long term activity) by processing behavior in the chemical bodies task. In this task, input spuriousness positively correlated with recall of "shape" and "number" characteristics of the figures.

In each of the two tasks, coding, coding efficiency, retrieval and retrieval efficiency were negatively related to input spuriousness, short term chunking, and chunking efficiency, but were positively related to long term memory chunking and long term coding efficiency. Figure sorting long term chunking and long term chunking efficiency was negatively correlated with output information, while processing was treated at the steady state (equivalent to random processing behavior, where events are no longer related).

We shall now study correlational similarities and differences of sex and culture by looking at each of the four groups one at a time. In males of the two cultures, set redundancy (K) in the chemical bodies task is positively related to the number of messages processed in the figure sorting task. This relation was not found in females of two cultures. Redundancy was positively related to input spuriousness, while it was related to processing the figure sorting task among Libyan subjects, and to the short term chunking among American subjects (Tables 5, 6, 7 and 8).

Groupings of figures for "color" reasons was positively related to the recall of "shape" characteristics in American subjects. In Libyan subjects, these reasons for set formation correlated negatively with "number", "shape" and "total" recall characteristics.

Among American males and Libyan females, groupings of figures according to two or more "attributes", was positively related to all recall (shape, color and number). This particular kind of practice was negatively related to M, M unit and M useful among Libyan males and females. The same relationship was positive in American females. No linear relationship of this kind was found for American males (Tables 7, 11).

TABLE 6

Significant Coefficients of Correlation Between Sorting Practice Characteristics and Sorting Recall, Chemical Bodies Task Characteristics and Dimension Algorithm Elements, Libyan Males*

Task Characteristics	P. Sets	P. Shape	P. Color	P. Number	P. Pattern	P. Other	P. Attributes
A. Figure Sorting Task Practice:							
P. Sets							
P. Shape	.41	.41	.66		.39	.47	-.45
P. Color	.66	.61					.45
P. Number							
P. Pattern	.39				.75	.75	
P. Other	.47						
P. Attributes		-.45	.45	.45			
B. Figure Sorting Task:							
S. Messages	.93	.41	.68			.39	
R. Total			-.51				
R. Shape							
R. Color							
R. Number		-.50	-.36		.43	.56	
C. Chemical Bodies Task:							
C. Messages	-.41						
Set Redundancy (K)	.48		.42				
1/K	-.41						
Solution Prob. (S)							
1/S							
M Unit	-.44		.49				
M	-.44		.49				
M Useful	-.44		.49				

*Significant at .1 level.

TABLE 7

Significant Coefficient of Correlation for Sorting and Chemical Bodies Characteristics, American Males*

<u>Task Characteristics</u>	<u>C. Messages</u>	<u>Set Redundancy (K)</u>	<u>1/K</u>	<u>Solution Prob. (S)</u>	<u>1/S</u>	<u>S. Messages</u>	<u>R. Total</u>	<u>R. Shape</u>	<u>R. Color</u>	<u>R. Number</u>
A. Chemical Bodies Task:										
C. Messages										
Set Redundancy (K)	-.49	-.49	-.66		.36	-.41				-.33
1/K		-.66		.35		.45				
Solution Prob. (S)	-.40		.35	-.96	-.96					
1/S	.36									
B. Figure Sorting Task:										
S. Messages	-.41									
R. Total		.45					.84	.70		.83
R. Shape										
R. Color								.47	.64	.46
R. Number								.75	.67	
M Unit		-.41						.76	.65	
M								.76		
M Useful								.93		

*Significant at .1 level.

TABLE 8

Significant Coefficients of Correlation Between Sorting Practice Characteristics and Sorting Recall, Chemical Bodies Task Characteristics and Dimension Algorithm Elements, American Males*

Task Characteristics	<u>P. Sets</u>	<u>P. Shape</u>	<u>P. Color</u>	<u>P. Number</u>	<u>P. Pattern</u>	<u>P. Other</u>	<u>P. Attributes</u>
A. Figure Sorting Task Practice:							
P. Sets	.74			.43			
P. Shape	.41	.74					
P. Color	.41	.52					
P. Number	.43						
P. Pattern							
P. Other							
P. Attributes							
B. Figure Sorting Task:							
S. Messages	.82	.49		.41	.32		.39
R. Total			.41		.46		.37
R. Shape							.39
R. Color							
R. Number							.35
C. Chemical Bodies Task:							
C. Messages							
Set Redundancy (K)				.33			
1/K				.41		.38	
Solution Prob. (S)							
1/S							
M Unit							.49
M							.50
M Useful							.50

*Significant at .1 level.

TABLE 9

Significant Coefficients of Correlation for Sorting and Chemical Bodies Characteristics
American Females*

Task Characteristics	C. Messages	Set Redundancy (K)	1/K	Solution Prob. (S)	1/S	S. Messages	R. Total	R. Shape	R. Color	R. Number
A. Chemical Bodies Task:										
C. Messages		-.65	.42							
Set Redundancy (K)			-.70							
1/K	.42									
Solution Prob. (S)					-.88					
1/S				-.88						
B. Figure Sorting Task:										
S. Messages						.33	.86	.33	.81	.38
R. Total						.33	.86	.86	.56	.83
R. Shape						.33	.86	.56	.52	.54
R. Color						.38	.90	.81	.81	.70
R. Number						.38	.90	.81	.81	.70
M. Unit						.38	.90	.81	.81	.70
M						.38	.90	.81	.81	.70
M Useful						.38	.90	.81	.81	.70

*Significant at .1 level.

TABLE 10

Significant Coefficients of Correlation Between Sorting Practice Characteristics
and Sorting Recall, Chemical Bodies Task Characteristics and Dimension
Algorithm Elements, American Females*

Task Characteristics	<u>P. Sets</u>	<u>P. Shape</u>	<u>P. Color</u>	<u>P. Number</u>	<u>P. Pattern</u>	<u>P. Other</u>	<u>P. Attributes</u>
A. Figure Sorting Task Practice:							
P. Sets	.94						
P. Shape							
P. Color							
P. Number					.39		
P. Pattern							
P. Other						.39	
P. Attributes							
B. Figure Sorting Task:							
S. Messages	.93	.81				.33	
R. Total			.37	.39			
R. Shape				.38			
R. Color					.33	.33	
R. Number					.41	.41	
C. Chemical Bodies Task:							
C. Messages							.34
Set Redundancy (K)							.46
1/K							
Solution Prob. (S)							
1/S							
M Unit							
M							
M Useful							

*Significant at .1 level.

TABLE 11

Significant Coefficients of Correlation for Sorting and Chemical Bodies Characteristics
Libyan Females*

Task Characteristics	C. Messages	Set Redundancy (K)	1/K	Solution Prob. (S)	1/S	S. Messages	R. Total	R. Shape	R. Color	R. Number
A. Chemical Bodies Task:										
C. Messages										
Set Redundancy (K)										
1/K	.40		.40							
Solution Prob. (S)										
1/S				-.97	-.97			.85	.78	.78
B. Figure Sorting Task:										
S. Messages										
R. Total										
R. Shape										
R. Color									.86	.90
R. Number								.86	.90	.88
M Unit										
M	.30	.29					.34			
M Useful		.30					.32			
		.37					.43			

*Significant at .1 level.

TABLE 12

Significant Coefficients of Correlation Between Sorting Practice Characteristics and Sorting Recall, Chemical Bodies Task Characteristics and Dimension Algorithm Elements, Libyan Females*

Task Characteristics	P. Sets	P. Shape	P. Color	P. Number	P. Pattern	P. Other	P. Attributes
A. Figure Sorting Task Practice:							
P. Sets				.85			.61
P. Shape				-.34			-.47
P. Color		.37					.51
P. Number	.85	-.34				.73	
P. Pattern					.73		
P. Other						-.32	
P. Attributes	.61	-.47		.51			
B. Figure Sorting Task:							
S. Messages	.40		.30				.53
R. Total				-.34			.52
R. Shape	.77		.37	.74			.42
R. Color	.71			.66			
R. Number	.64			.65			
C. Chemical Bodies Task:							
C. Messages							.37
Set Redundancy (K)							
l/K	.69			.67			
Solution Prob. (S)							
l/S							
M Unit					.49	.32	-.41
M					.50	.32	-.41
M Useful							-.34

*Significant at .1 level.

TABLE 13

Significant Coefficients of Correlation Between Chemical Bodies Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, Libyan Males*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	LTM:M ¹	%LTM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS	H(Y)/SS
A. Figure Sorting Task Practice:										
P. Sets								.41		
P. Shape										
P. Color										
P. Number					-.45					
P. Pattern								.50	.51	
P. Other								.50	.49	
P. Attributes										
B. Figure Sorting Task:										
S. Messages										
R. Total			.36		-.37	.38				
R. Shape										
R. Color			-.39							
R. Number								-.37		
C. Chemical Bodies Task:										
C. Messages	-.78	-.83	-.70		.83	.93	.76			
Set Redundancy (K)	.54	.54	.49		-.55	-.60	-.49			
l/K	-.50	-.50	-.42		.66	.78	.43			
Solution Prob. (S)	.47	.46			-.42	-.42	-.42			
l/S	-.36				.43	.38				
M Unit										
M										
M Useful										

*Significant at .1 level.

TABLE 14

Significant Coefficient of Correlation Between Figure Sorting Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, Libyan Males*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	LTM:M ¹	%LTM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS
A. Figure Sorting Task Practice:									
P. Sets	-.73	-.76	-.66	-.67	.74	.77	.70		
P. Shape					.49	.54			
P. Color		.36			.88	.82			
P. Number								.46	.46
P. Pattern	-.43	-.41	-.47	-.32			.45		
P. Other	-.52	-.51	-.55	-.47			.54		
P. Attributes								.36	
B. Figure Sorting Task:									
S. Messages	-.75	-.79				.84	.72		
R. Total					-.42	-.44			
R. Shape			.37			-.40			
R. Color	.37								
R. Number									
C. Chemical Bodies Task:									
C. Messages			-.67	.71	.80				
Set Redundancy (K)	-.51	-.53	.48	-.51			.51		
1/K	.47	.51	.40	.50			.50		
Solution Prob. (S)					.36			.41	.40
1/S									
M Unit	.42	.41	.42	.41	-.46	.49	-.37		
M	.42	.41	.42	.41	-.46	.49	-.37		
M Useful	.42	.41	.42	.41	-.46	.49	-.37		

*Significant at .1 level.

TABLE 15

Significant Coefficients of Correlation Between Chemical Bodies Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, American Males*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	ITM:M ¹	%ITM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS	H(Y)SS
A. Figure Sorting Task Practice:										
P. Sets										
P. Shape										
P. Color										
P. Number										
P. Pattern										
P. Other										.66
P. Attributes										
B. Figure Sorting Task:										
S. Messages	-.37	.39	.35	.37		-.33	-.38			
R. Total										
R. Shape										
R. Color										
R. Number						-.30				
C. Chemical Bodies Task:										
C. Messages	-.76	-.82	-.72	-.73	.66	.70	.78	-.45	-.44	.45
Set Redundancy (K)	.74	.71	.74	.70	-.33	-.47	-.69			-.52
l/K	-.51	-.45	-.54	-.45			.47			
Solution Prob. (S)					-.47	-.48		.54	.54	
l/S					.42	.44		-.50	-.49	
M Unit										
M										
M Useful										

*Significant at .1 level.

TABLE 16

Significant Coefficients of Correlation Between Figure Sorting Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, American Males*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	LTM:M ¹	%LTM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS
A. Figure Sorting Task Practice:									
P. Sets	.80	-.79	-.72	-.71	.69	.71	.70	.47	
P. Shape	-.46	-.43	-.38	-.37	.54	.57	.34	.64	.66
P. Color								.56	
P. Number	-.49	.52	-.50	-.49			.53		
P. Pattern									
P. Other									
P. Attributes						.34			
B. Figure Sorting Task:									
S. Messages	-.77	-.80	-.65	-.72	.88	.90	.67		
R. Total									
R. Shape					.36	.33			
R. Color									
R. Number									
C. Chemical Bodies Task:									
C. Messages	.39	.37	.34	.35	-.37	-.39			
Set Redundancy (K)		-.33			.34	.38	-.32		
1/K									
Solution Prob. (S)	-.40								
1/S									
M Unit									
M									
M Useful									

*Significant at .1 level.

TABLE 17

Significant Coefficients of Correlation Between Chemical Bodies Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, American Females*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	LTM:M ¹	%LTM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS	H(Y)SS
A. Figure Sorting Task Practice:										
P. Sets										
P. Shape										
P. Color										
P. Number										
P. Pattern			.32					-.36		
P. Other										
P. Attributes	.45	.44	.46	.40			-.44			.32
B. Figure Sorting Task:										
S. Messages										
R. Total										
R. Shape								-.36	.35	
R. Color								.33	-.32	
R. Number										
C. Chemical Bodies Task:										
C. Messages	.90	-.91	-.87	.70	.60	.82	.87	-.43	-.43	
Set Redundancy (K)	.60	.63	.59	.37	.40	-.46	-.61	.34	.35	
1/K	-.43	-.44	-.43	-.33			.44			
Solution Prob. (S)										
1/S										
M Unit										
M										
M Useful										

*Significant at .1 level.

TABLE 13

Significant Coefficients of Correlation Between Figure Sorting Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, American Females*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	ITM:M ¹	%ITM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS
A. Figure Sorting Task Practice:									
P. Sets	-.79	-.74	-.75	-.63	.74	.93	.69	.86	.89
P. Shape	-.58	-.52	-.54	-.39	.65	.87	.45	.91	.95
P. Color								-.49	-.46
P. Number	-.47	-.51	-.49	-.56			.54		
P. Pattern									
P. Other									
P. Attributes									
B. Figure Sorting Task:									
S. Messages	-.89	-.86	-.85	-.77	.85	.95	.81	.67	.71
R. Total	-.35	-.36		-.35	.46		.33		
R. Shape	-.39	-.40	-.34	-.39	.53	.36	-.36		
R. Color									
R. Number	-.38	-.38	-.36	-.35	.38	.37	.36		
C. Chemical Bodies Task:									
C. Messages									
Set Redundancy (K)									
1/K									
Solution Prob. (S)									
1/S									
M Unit									
M									
M Useful									

*Significant at .1 level.

TABLE 20

Significant Coefficients of Correlation Between Figure Sorting Information Measures
and Characteristics of the Chemical Bodies and Sorting Task, Libyan Females*

Task Characteristics	CODE	%CODE	REAL:M ¹	%REAL:M ¹	ITM:M ¹	%ITM:M ¹	NOISE:X:M ¹	REAL:SS	%REAL:SS
A. Figure Sorting Task Practice:									
P. Sets	-.65	-.54	-.63	-.53	.39	.44	.52		
P. Shape									
P. Color	-.36	-.46	-.38	-.48			.49		
P. Number	-.38		-.36						
P. Pattern					.42	.42		.37	.39
P. Other					.40	.39		.46	.48
P. Attributes	-.32		-.33						
B. Figure Sorting Task:									
S. Messages	-.74	-.81	-.68	-.74	.73	.84	.75		
R. Total									
R. Shape									
R. Color									
R. Number									
C. Chemical Bodies Task:									
C. Messages					.38				
Set Redundancy (K)									
l/K									
Solution Prob. (S)									
l/S									
M Unit					.31		.31		
M					.29			-.38	-.31
M Useful									

*Significant at .1 level.

In all groups, with the exception of the Libyan Female group, set redundancy was positively correlated with useful information and negatively related to short term chunks and input spuriousness in the chemical bodies task.

In the Libyan female group, sub recall (shape, color, number) as well as "total recall" score, correlated negatively with the amount of useful information (coding, retrieval) in the chemical bodies task (Table 19). In American females, recall of "shape" and "number" items were negatively correlated to the same corresponding functions in the figure sorting task (Table 18).

In American subjects, processing of useful information (coding, coding efficiency, retrieval, and retrieval efficiency) done while processing the figure sorting task, was negatively related to "shape" recall and to the "total recall score". In this group these processing values were also negatively related to grouping of figures for two or more "attributes" (Tables 16, 18). No such relationships were found among Libyan subjects. However, in Libyan subjects these processing values were negatively related to "color", "pattern" and "other" reasons for group formations. No relationships of this kind were found in American subjects (Tables 12, 14).

Useful information behaviors, occurring while processing the chemical bodies task, were found to correlate negatively with all recall and recall subscores among Libyan subjects and not among American subjects (Tables 14, 19).

The amount of input spuriousness, in the processing of the figure sorting task, positively correlated to "shape" as well as "total" number of reasons for set formations in each of the four groups. However, this spuriousness was positively related to "color", "pattern" and "number" reasons for set formations among Libyan subjects and not among American subjects. The spuriousness measure of American subjects correlated positively with figures recalled for "shape" characteristics. Spuriousness, accompanied with the processing of the chemical bodies task, was related positively to recall and subrecalls among Libyan subjects, and negatively correlated to "pattern" reasons for set grouping among American subjects (Tables 14, 19).

Basic memory structure (M unit) increment change (M) and schematic structure, were found to be negatively related to the amount of chunking in the long term memory processing of useful information, done while processing the figure sorting task, and positively correlated to number of elements combined, input spuriousness in the chemical bodies task and set redundancy (K). All these relationships were found to occur among Libyan subjects and not among American subjects (Tables 11, 12, 13 and 14). In American subjects, however, these values were found to be related to chunking in the long term memory, done while processing the chemical bodies task (Tables 17, 18).

Conclusion and Discussion

The study was done to compare sex and cultural differences of tenth-grade American and Libyan subjects who did the Piagetian chemical bodies task, a figural sorting task, and an immediate recall for the sorting task. A unique approach was done by calculating the information flow for the behaviors of the subjects performing the two tasks.

The chemical bodies task performance was not analyzed in the typical Piagetian manner because of the language meaning incongruencies existing for the subjects.

The task actions were analyzed by developing two instruments which determined instance reactions (S) and combinational redundancy patterns for solving the problem (K).

The females of the two cultures did not differ as to the redundancy of bodies combinations, whereas American males had a significantly higher redundancy pattern than practiced by Libyan male subjects. The tendency for avoiding negative instances (S) was found to be a function for successful solution potential. The subjects who increased the variety of bodies, combined in the first few trials, were found to more frequently do a successful problem solution. The probability of avoiding a negative stimulus (sodium thiosulfate as the negative stimulus), or S, was not found to significantly differ for the subjects of the two cultures. However, Libyan females solved the problem with a lower tendency to experience the negative effect, as compared to Libyan male subjects. The American male subjects had the highest probability of stimulus avoidance. It was concluded that the performance of the chemical bodies task was sex-oriented as to cultures.

The subjects did the practice aspect of the figural sorting task by constructing sets for specified reasons. The American subjects made more classificatory sets, and thereby more set elements, than constructed by Libyan subjects. There were no sex differences for the set formation traits. The reasons accounting for more classification activity by American subjects was for sets with shape and color attributes and American male subjects constructed significantly greater numbers of sets for figure color reasons. The Libyan subjects made more sets for reasons of two or more task attributes, and for reasons not categorized by perceived properties of task figures (other). The attributes practice was done to the greatest frequency by Libyan females. These performance differences for the figural learning tasks afforded the conclusion that the tenth-grade subjects had distinct classification operations, depending on culture environments.

It was quite surprising to find that subjects of the same grade level in two cultures did not differ as to the level of cognition for an immediate recall of the total number of figures and properties of the figural sorting task. They did differ as to the recall of color properties and identity numbers of the figures, the former done by American subjects and the latter by Libyan subjects. The ability to recall color properties of the figures was distinguished by Libyan female subjects at the highest level and was least remembered by American male subjects. The opposite sex effect occurred for the recall of shapes of figures with American females having the highest level of cognition.

These patterns of cognition for recall of shape and color being favored for females are supported by Hutt (11) who indicated that females can hold more items in their short term memory, for a short time, than can males. Smock (12) and Mendel (13) found that males are more curious, leading them to wonder about objects and to seek general concepts or relationships, whereby females more readily commit the objects to rote memory.

The question of the way in which the task behaviors and cognition were related to each other was explored with linear regression analyses. The strategy for negative instance reactions (S) and redundancy patterns (K) were not found to be related for American males and American and Libyan female subjects. The chemical bodies traits were found positively related for Libyan males.

The question can be raised as to what is the importance of the K factor, or redundancy of patterns in doing the chemical bodies task. The total population of subjects was tested with linear regression analysis to explore for an answer.

An inverse of K was positively related to the sorting practice sets of use of two or more attributes, sets for number reasons, and the number of messages written as set elements in the sorting task. The $1/K$ treatment was also negatively related to the practice color sets formed in the sorting task. On the other hand, the inverse of the redundancy factors was positively related to the recall of shape, color, and number in the sorting task. It seems that the repetition of combinations of chemical bodies is a behavior set which describes cognitive differentiation for learning being related to cognitions by humans. This conclusion is possible if it is kept in mind that the K factor describes behavior in one task, and is related to learning and cognition in another task done by the same humans.

The relationship of the K and S factors for Libyan male behavior was seen as the inverse of K being negatively related to the S factor. It was also found to be positively related to the number of chemical bodies used in the task. The Libyan males used more chemical bodies as there was an increase in repetition of combinations per element involved in the task and as there was an increase of the probability for avoiding the negative instance upon recognizing the negative effect, or instance, of combinations he had completed. This characteristic of the performance of Libyan male subjects is indicative of a Brunerian concept of a focusing strategy shifting to one of scanning (14). This interpretation is supported by the finding that the $1/K$ factor for Libyan male subjects was negatively related to the number of set elements written in the practice sorting task. There were no negative instances in the sorting task enabling the strategist to do a lower cognitive strain task; in a manner compatible to his perceptual set. The concept attainment behavior pattern of Libyan male subjects will be discussed later with regard to cognition characteristics for information flow.

The relationships between the behaviors of the tenth-grade subjects who did the two different kinds of task were not readily apparent. It will be proven later the relationships between tasks were uniquely of patterns of information memory flow. The link between the chemical bodies task and practice learning behaviors of the sorting task, were found to be only for American subjects. Female American subjects were found to have a negative relationship between the number of chemical bodies combined and the number of sets formations for number reasons. A unique pattern evolved when it was found they also had a positive relationship for that kind of set formation and the K factor, or redundancy pattern of the chemical bodies task. The American male subjects also had a positive relationship of the K factor with the presenting of "other" reasons for set formations.

The direct linear relationships between kinds of practice set formations and kinds of figure property recall were found to distinguish the sex characteristics of the subjects of the two cultures. Both female and male subjects of the American culture had direct relationships of the practice of color sets and the recall of shapes of figures. The same kind of recall was directly related to the number of set elements made in the practice task. The use of practice pattern set formations were related to the total cognitions of females and males. Another finding was that the American subjects had practice behaviors which were only positively related to cognition behaviors.

The conclusion that learning behaviors were positively related to the figural sorting task cognition for American subjects did not prevail for the behaviors of Libyan subjects. Both male and female Libyan subjects had negative relationships between the recall total score and the practice set formations, of color for males and number for female subjects. The recall of identity numbers of figures was negatively related to the amount of set formations for color reasons by both

sex groups. The male Libyan subjects had no other relationships of practice learning behaviors and recall of the sorting task. On the other hand, the Libyan and American females were similar in their having direct relationships for the amount of set element entries and recall of shapes and identity numbers of figures.

The question which should be raised here is: there being behavior differences by sex groups of the two cultures, how can this be explained in terms of the human memory. After all, the subjects were engaged in similar tasks, and processing a basically similar memory. The matter is one of the nature of the information flow in the human memory. The question is then phrased as whether or not the four culture sex groups of humans had similar flow of memory information. It can be proven they did not by a study of the linear operators of memory elements between the two tasks, within each task, and for relationships with learning and cognition tasks.

In order to narrow the analysis of memory processing by subject groups of humans and to make the conclusions more understandable, the first propositions of each presentation will be of how one could identify a culture sex group.

Libyan female subjects had linear operators of short term memory useful information with that of the long term memory in the channel bodies task and the counterparts of the sorting task. They did not process this useful information in a connection with the amount of general overt behaviors in either learning task. Quite uniquely, and distinguishing female Libyan subjects, the long term memory useful information of the two tasks were negatively related to each other. The Libyan female subjects had a direct relationship of the lack of redundant behaviors and amount of flasks used in the sorting task. The M dimension structure of memory information was also directly related to the amount of redundancy practiced in the chemical bodies task. Moreover, the increment level of the M structure of the memory was negatively related to the sorting task useful information of the long term memory processed per behavior in that learning task. These pathways of linear operators indicate Libyan females probably have a form of inverse arrangement of long term memory information. This conclusion is supported by the discovery that the recall of distinct properties (shape, color, and identity number) in the figural sorting task was positively related to the inverse of the redundancy factor (K) of the chemical bodies task. If one examines the tendencies of practice sorting learning tasks by the female Libyan subjects it is discovered that they utilized short term memory processing for behavior decisions and one of these, the use of two-or-more attributes for set formations was inversely related to the strategy of redundancy in the combinations of flasks in the chemical bodies task. As the attributes characteristic is regarded as an advanced mental maturation operation, one is again drawn to the conclusion that the intellect of memory structure of Libyan females is one of some kind of inverse structuring of logarithmic information.

The Libyan male does differ from his counterpart of the Libyan culture. The difference is quite logical when considering memory components and functions. The M dimension of the information structure was reported as positively related to short term memory useful information of Libyan female subjects. The opposite relationship existed for the male subjects. The contrast was that the male subjects had the M structure positively and exclusively related to the encoding elements of the short and long term memory stores involved in the learning actions in the figural sorting task. This encoding characteristic of the information flow of the chemical bodies task was positively related to the avoidance-of-negative-instance behaviors (S), and that factor was positively related to the redundancy practice (K) of the same task.

The question which should surface here, if the memory of these two sexes of the Libyan culture are different, is how information is processed in the memory of Libyan male subjects? A study of the linear regression findings show that Libyan male subjects are not uniquely characteristic in the cognition aspects of the figural sorting task. They differed from the female subjects in the relationship of sorting practice behaviors to the information flow of tasks. These differences were manifested by useful information storage in the memory. The linear operators were of the chemical bodies task for male subjects and the sorting learning task for the females. An examination of internal memory information flow for each of the tasks revealed the Libyan male subjects differed from female subjects by their having a relationship between short term memory information and their perception of the sorting task (NOISE:X:M^1). Thus, the NOISE:X:M^1 of the chemical bodies task was positively related to short term memory useful information, and in turn the same element was negatively related to the short term memory of the sorting task. The long term memory useful information of the sorting task was negatively related to the level of cognition of the total properties of the sorting task. The tendency to avoid an observed negative instance (S) in the chemical bodies task by the male subjects was negatively related to the sorting task total cognition. The tendency to have a redundancy of flasks in the chemical bodies task was positively related to the S factor of the male Libyan subjects. The difference between Libyan female and male subjects was concluded to be that the males operated an encoding system more closely related to behavior actions in the experiment tasks and that the unit of structure of memory information was probably arranged differently than that of the female Libyan subjects.

The American female group of subjects were distinct in having no linear relationship of information flow between the memory processing involved in conducting the two tasks of this study. However, this disparity was of a logical explanation when the exclusive traits for this group of subjects was examined. These subjects were much like the Libyan female subjects in that the unique characteristics attributable to their behaviors were almost completely with relationships of the useful information processing of their memory stores. The primary aspect was that, unlike Libyan female subjects, the long term memory useful information in processing the chemical bodies task was directly related to the tendency to execute redundant combinations of flasks in solving the chemical bodies problem. The same information component was negatively, or indirectly related to the total level of cognition of the figural sorting task. Furthermore, as they did the sorting task set formations, the long term memory useful information increased.

The American female subjects differed from the Libyan female subjects in the relationship of encoding processes of the sorting and chemical bodies task and the total recall and the recall of number properties in the sorting task. They differed from the American male subjects on the relationship of information flow of useful information in the short term memory store for the recall of shape and number properties. They were unique in having linear operators existing for redundancy strategies of combining the chemical bodies. Their strategy was directly related to long term memory useful information, which was found to be uniquely related to the nature of encoding in doing the chemical bodies task. The long term memory flow of useful information for processing behaviors for the sorting learning task were completely different for linear operators of encoding processes. The conclusion drawn for typifying American female subjects of the operational level was that they processed information in an interrelating manner between encoding processes and the long term memory store. The pathway of

relationship seemed to change, largely depending on the task being done and thus the nature of the utilization of useful information.

The profile of distinguishing characteristics for memory processing by American male subjects was clearly one of an awareness of overt learning behaviors. In other words, they had linear relationships uniquely associated between set formations and messages processed in the sorting and chemical bodies tasks; the redundancy strategies of the chemical bodies task. In turn they were like the Libyan male subjects for these relationships, but differed as to the relationships for short term useful memory storage and processing. This difference could be an explanation of how the Libyan and American male subjects differed for the strategy used after experiencing a negative instance (S) in the chemical bodies task (previously mentioned for discussion of Libyan males). Quite singularly the redundancy practices of American male subjects was one of a spatial perception of objects; this is supported by the linear operators they had for pattern set formations of the sorting task. They then had a tendency to differ from the Libyan male subjects in increasing the number of flasks used in the chemical bodies task as they noted a negative instance. The Libyan male subjects differed by adopting a more cautious behavior of using flasks for the same detection event. The same pattern of behaviors existed for the subjects of male sex in the processing of sorting task messages, as a linear operator with redundancy behaviors of the chemical bodies task.

The American males were identified with the American females in the linear relationships of encoding information processes and useful information of the long term memory store. They processed information related to the functions of the sorting and chemical bodies task much like that manner employed by Libyan males. This was the pattern of encoding processes of the chemical bodies task being related to the chunking effect which occurred when the subjects did the learning experience of the figural sorting task.

The materials for doing the tasks were the same even though their performances were in two different cultures. We now know the subjects of the two cultures were able to achieve similar levels of total memory recall, even though they differed as to how the properties of the figural task played roles in that recall. The subjects of the cultures differed as to how they did the learning aspects of the tasks. Their behaviors differed as to the repetition of combinations of chemical bodies in the Piagetian task and the kinds of figural groups in classificatory activities. These are major discoveries but they do not define the delineations of memory information flow found for culture and sex.

The patterns of differences and linear operators of memory information processing can be explained by a simple consideration of the tasks and subjects of the cultures doing the two learning tasks. The subjects visually perceived the environment objects of each task. That ordinary information entered the human memory and was processed out as observable behaviors of how the subject had cognitively treated the learning material from the original environment. These behaviors were those used for establishing information measures to describe the nature of the structure of the total behavior repertoire. Thusly, the information measures were descriptors of how the memory was typified by the sex and cultural characteristics.

A layman's synopsis of how tenth-grade subjects of different sexes and cultures did the tasks is actually a description of how the humans processed environment learning material through the memory. Libyan females are unique in probably having unit information structures or information pathways operating in some kind of inverse logarithmic fashion. The Libyan male subjects differ in having a more efficient system of encoding environment information for storage. The American female subject utilizes the long term memory information storage with a less heuristic encoding scheme. Finally, the American male is unique in processing memory information in a way which is more closely related to the dimensions of the perceived environments and by a more active short term memory treatment of information chunking and processing.

This study is then the first report of research which describes cultural differences of information processing by young adult humans in their performance of a Piagetian task and the learning of a figural task for an immediate cognition. It should provide future science education researchers a new strategy for studying human differences in learning and cognition tasks.

BIBLIOGRAPHY

- (1) Were, K., "A Survey of the Thought Processes of New Guinean Secondary Students" Unpublished M.Ed. Thesis. University of Adelaide, Australia, 1968.
- (2) Kelly, M. R., "Some Aspects of Conservation of Area and Length in Papua and New Guinea in Relation to Language, Sex, and Years at School." Territory of Papua and New Guinea Journal of Education, 1970, p.p. 55-60.
- (3) Vernon, P. E., "Educational and Intellectual Development Among Canadian Indians and Eskimos." Education Review, Vol. 18, 1966. pp. 79-91 and 186-195.
- (4) Vernon, P. E. Intelligence and Cultural Environment. London, Methuen, 1969.
- (5) ZaRour, G. I. "The Conservation of Number and Liquids by Lebanese School Children in Beirut." Journal of Cross Cultural Psychology, Vol II, 1971. pp. 165-172.
- (6) Moser, Gene W., The Use of Information Theory to Study Human Learning. Detroit, Michigan: Symposium presented at the Annual Conference of National Association for Research in Science Teaching, 29 March, 1973.
- (7) Empfield, C. O., "Differences in Memory Information Processing as Related to Visual-Oral Treatment, Verbal and Visual Recall Tasks, and Children of Ages Five, Nine and Thirteen Years." Doctoral Dissertation, University of Pittsburgh, Pittsburgh, Pa. 1973.
- (8) Dunlop, David L., "An Information Theoretic Analysis of Classification Sorting and Cognition by Ninth Grade Children Within a Piagetian Setting." Doctoral Dissertation, University of Pittsburgh, Pittsburgh, Pa. 1973.
- (9) Moser, Gene W., An Information Theoretic Model for the Human Processing of Cognitive Tasks. Chicago, Illinois: Paper presented at Conference of National Association for Research in Science Teaching, 4 April, 1972.
- (10) Piaget, Jean and B. Inhelder et al., Memory and Intelligence. Basic Books, Inc., New York, 1973.
- (11) Hutt, C., Males and Females. Penguin Science of Behavior, New York., 1972.
- (12) Smock, C. D. and B. G. Holt, "Children's Reaction to Novelty: An Experimental Study of 'Curiosity Motivation'". Child Development. Vol. 33, pp. 631-642, 1962.

- (13) Mendel, G., "Children's Preferences for Differing Degrees of Novelty," Child Development. Vol. 36, pp. 453-465, 1965.
- (14) Bruner, J. S., Goodnow, J. J. and Austin, G. A. A Study of Thinking. New York: Science Editions, Inc., 1962.
- (15) Inhelder, B. Piaget, J., "Growth of Logical Thinking" Basic Books Inc., 1958.

A P P E N D I C E S

TABLE 21

Analyses of Variance Between Cultures, Between Sex, and Sex and Culture

Task Characteristics	Culture		Sex		Culture & Sex		Error MS
	MS	F*	MS	F*	MS	F*	
A. Chemical Bodies Task:							
Messages							81.41
Set Redundancy (K)	.9126	3.591					.2541
1/K	210.00	3.520	257.00	3.158			59.68
Selection Probability (S)							
1/S					.0389	3.454	.0113
					2.280	4.866	.4686
B. Figure Sorting Task:							
Messages	9326.00	17.730					526.00
Practice Sets	195.60	3.548					52.32
Practice Shape	261.00	7.724					33.80
Practice Color	33.55	5.814	25.03	4.338			5.772
Practice Other	41.88	7.961					5.261
Practice Attributes					17.59	3.344	4.386
Recall Total			29.27	6.675	36.42	8.305	38.99
Recall Shape			132.80	3.406			19.45
Recall Color			61.40	3.156			12.18
Recall Number	56.41	4.102	35.72	2.932			13.75
Information Measures							
A. Chemical Bodies Task:							
LTM:M1	.0158	5.427	.0109	3.766			.0290
%LTM:M1	.0154	3.4850	.0209	4.751			.0044
H (Y) SS			.0331	3.752			.0283

TABLE 21 (cont.)

Analyses of Variance Between Cultures, Between Sex, and Sex and Culture

Information Measures (cont.)	Culture		Sex		Culture & Sex		Error MS
	MS	F*	MS	F*	MS	F*	
B. Figure Sorting Task:							
CODE	3.667	17.960			.8352	4.091	.2041
%CODE	.3563	23.850			.0718	4.806	.0149
REAL:M ¹	3.028	17.080			.9323	5.256	.1774
%REAL:M ¹	.4542	23.58			.1067	5.540	.0193
LTM:M ¹	.0214	4.756					.0045
%LTM:M ¹	.0080	6.354					.0013
NOISE:X:M ¹	.3127	24.100			.0764	5.891	.0130
REAL:SS	.1180	5.263					.0224
%REAL:SS	.0020	3.510					.0006
M-Unit			.0454	4.083	.0320	2.876	.0104
M			274.9	4.273	222.00	3.450	64.35
M Useful			.0372	3.601			.0103

*F test value significant at .1 level for 1 and 104 degrees of freedom.

TABLE 22

Analyses of Variance Between Cultures, Between Sex, and Sex and Culture*

Task Characteristics	Culture		Sex		Culture & Sex		Error MS
	MS	F	MS	F	MS	F	
A. Chemical Bodies Task:							
Messages	221.70	2.723	257.10	3.158	2.917	.0358	81.41
Set Redundancy (K)	.9126	3.591	.0069	.0270	.6721	2.645	.2541
1/K	210.00	3.519	50.45	.8454	67.39	1.129	59.53
Solution Probability (S)	.0108	.9569	.0012	.1059	.0389	3.454	.0113
1/S	.1705	.3636	.0697	.1488	2.280	4.866	.4686
B. Figure Sorting Task:							
Messages	9326.00	17.73	34.29	.0652	882.20	1.677	526.00
Practice Sets	185.60	3.547	4.084	.0781	18.27	.3492	52.32
Practice Shape	261.00	7.724	.6889	.0204	43.69	1.293	33.79
Practice Color	33.55	5.814	25.03	4.338	.1808	.0313	5.772
Practice Number	10.96	.7061	12.22	.7871	19.80	1.275	15.53
Practice Pattern	1.332	1.703	.0195	.0249	.0586	.0749	.7820
Practice Other	41.88	7.961	8.173	1.554	17.59	3.344	5.261
Practice Attributes	36.42	8.305	29.28	6.675	6.499	1.482	4.386
Recall Total	15.91	.4080	132.80	3.406	.4229	.0108	38.99
Recall Shape	44.62	2.294	61.40	3.156	6.223	.3199	19.45
Recall Color	10.42	.8551	35.72	2.932	1.955	.1605	12.13
Recall Number	56.41	4.102	33.17	2.412	23.09	1.679	13.75

*For 1 and 104 degrees of freedom.

TABLE 23

Analyses of Variance Between Cultures, Between Sex, and Sex and Culture*

Information Measures	Culture		Sex		Culture & Sex		Error MS
	MS	F	MS	F	MS	F	
A. Chemical Bodies Task:							
CODE	.1453	.9699	.1069	.7130	.0557	.3714	.1500
%CODE	.0357	1.169	.0238	.7788	.0182	.5978	.0305
REAL:M ¹	.0671	.4881	.0513	.3806	.0498	.3693	.1347
%REAL:M ¹	.0279	.8831	.0341	1.080	.0184	.5812	.3158
LTM:M ¹	.0158	5.427	.0109	3.766	.0001	.0271	.0290
%LTM:M ¹	.0154	3.485	.0209	4.751	.0022	.4804	.0044
NOISE:X:M ¹	.0143	.5150	.0088	.3158	.0210	.7566	.0277
REAL:SS	.0001	.0068	.0179	1.465	.0163	1.332	.0122
%REAL:SS	.0002	.1922	.0026	.0441	.0028	2.203	.0013
H (Y) SS	.0007	.0771	.0331	3.752	.0000	.0032	.0283
B. Figure Sorting Task:							
CODE	3.667	17.96	.1467	.7185	.8352	4.091	.2041
%CODE	.3563	23.85	.0133	.8881	.0718	4.806	.0149
REAL:M ¹	3.029	17.08	.1362	.7681	.9323	5.256	.1774
%REAL:M ¹	.4542	23.58	.0265	1.378	.1067	5.540	.0193
LTM:M ¹	.0214	4.756	.0010	.2254	.0011	.2444	.0045
%LTM:M ¹	.0080	6.354	.0005	.3801	.0000	.0093	.0013
NOISE:X:M ¹	.3127	24.10	.0114	.8813	.0764	5.891	.0130
REAL:SS	.1180	5.263	.0401	1.788	.0083	.3708	.0224
%REAL:SS	.0020	3.510	.0005	.9733	.0002	.3946	.0006
M-Unit	.0220	1.976	.0454	4.083	.0320	2.876	.0104
M	129.1	2.006	274.9	4.273	.221.0	3.450	64.35
M Useful	.0155	1.501	.0371	3.601	.0221	2.135	.0103

*For 1 and 104 degrees of freedom.

TABLE 24

Significant Differences Between Cultures Across Tasks, Between
Tasks Across Cultures, Between Cultures and Tasks

Information Measures	Cultures		Tasks		Cultures & Tasks		Error MS
	MS	F*	MS	F*	MS	F*	
CODE	1.380	8.710	90.99	455.1	2.990	14.96	.20
%CODE	.0990	4.910	1.260	49.38	.3400	13.43	.03
REAL:M ¹	.01	9.150	.8900	513.8	.0200	13.17	.0017
%REAL:M ¹	.1200	5.820	1.308	47.23	.4600	16.67	.03
LTM:M ¹					.0388	10.07	.0039
%LTM:M ¹	.0031	4.966	.0386	59.22	.0056	6.586	.0007
NOISE:X:M ¹	.1083	5.944	.9953	43.88	.2698	11.89	.0227
REAL:SS	.0591	3.9197					
%REAL:SS			.0038	5.018			.0008

*F test value significant at .05 level for 1 and 106 degrees of freedom.

TABLE 25

Differences Between Cultures Across Tasks Between Tasks Across
Cultures, and Between Cultures and Tasks*

Information Measures	CULTURES		Tasks		Cultures & Tasks		Error
	MS	F	MS	F	MS	F	MS
CODE	1.380	8.710	90.99	455.1	2.990	14.96	.20
%CODE	.0990	4.910	1.260	49.38	.3400	13.48	.03
REAL:M ¹	.01	9.150	.8900	513.8	.0200	13.17	.0017
%REAL:M ¹	.1200	5.820	1.308	47.23	.4600	16.67	.03
LTM:M ¹	.0001	.039	.0039	1.022	.0388	10.67	.0039
%LTM:M ¹	.0031	4.966	.0386	59.22	.0056	8.586	.0007
NOISE:X:M ¹	.1083	5.944	.9953	43.88	.2698	11.89	.0227
REAL:SS	.0591	3.9197	.0553	2.813	.0435	2.215	.0197
%REAL:SS	.0009	1.643	.0038	5.018	.0008	1.032	.0008

*For 1 and 106 degrees of freedom.